

OPTICAL MODULATING DEVICE HAVING GATE STRUCTURE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Patent Application No. 62/197,331, filed on Jul. 27, 2015 in the U.S. Patent and Trademark Office, and priority from Korean Patent Application No. 10-2016-0007548, filed on Jan. 21, 2016 in the Korean Intellectual Property Office, the disclosures of which are incorporated herein by reference in their entireties.

BACKGROUND

[0002] 1. Field

[0003] Apparatuses consistent with exemplary embodiments relate to optical devices for modulating light.

[0004] 2. Description of the Related Art

[0005] Optical devices for modulating transmittance/reflection, polarization, phase, intensity, optical path, etc. of incident light are used in various optical apparatuses. Also, optical modulators of various structures are provided to control the properties described above in an optical system in a desired manner.

[0006] For example, structures such as liquid crystals having optical anisotropy, a microelectromechanical system (MEMS) using minute mechanical motion of an optical shielding/reflecting element, etc. are widely implemented in general optical modulators. These general optical modulators have a slow operational response rate of several μ s, due to characteristics of driving methods thereof.

[0007] There have been attempts to implement a nanoantenna using surface plasmon resonance occurring at a boundary between a metal layer and a dielectric layer, in optical devices.

SUMMARY

[0008] Exemplary embodiments may address at least the above problems and/or disadvantages and other disadvantages not described above. Also, the exemplary embodiments are not required to overcome the disadvantages described above, and may not overcome any of the problems described above.

[0009] Exemplary embodiments provide optical devices for modulating light.

[0010] According to an aspect of an exemplary embodiment, there is provided an optical modulating device including a permittivity change layer having a variable permittivity, a dielectric layer disposed on the permittivity change layer, a nanoantenna disposed on the dielectric layer, and a light-emitting structure disposed adjacent to the permittivity change layer.

[0011] The light-emitting structure may be configured to emit light having a greater wavelength than light incident on the light-emitting structure in response to the incident light, as an excitation source.

[0012] The light-emitting structure may include light-emitting particles.

[0013] The optical modulating device may further include an insulating material layer on which the permittivity change layer is disposed, the light-emitting particles being embedded in the insulating material layer.

[0014] The light-emitting structure may include a semiconductor quantum well or a semiconductor PN junction.

[0015] The optical modulating device may further include a metal layer on which the light-emitting structure, the permittivity change layer, the dielectric layer, and the nanoantenna are sequentially disposed.

[0016] The optical modulating device may further include a voltage-applier configured to apply a voltage between the permittivity change layer and the nanoantenna.

[0017] The permittivity change layer may include an active area in which a carrier concentration changes based on the applied voltage.

[0018] The permittivity change layer may include a transparent conductive oxide.

[0019] An optical apparatus may include the optical modulating device.

[0020] According to an aspect of another exemplary embodiment, there is provided an optical modulating device including a substrate, nanoantennas disposed on the substrate and spaced apart from one another, a dielectric layer disposed on the nanoantennas, a permittivity change layer disposed on the dielectric layer and having a variable permittivity, and a light-emitting structure disposed on the permittivity change layer and between the nanoantennas.

[0021] The light-emitting structure may be configured to emit light having a greater wavelength than light incident on the light-emitting structure in response to the incident light, as an excitation source.

[0022] The light-emitting structure may include light-emitting particles.

[0023] The optical modulating device may further include an insulating material layer disposed on the permittivity change layer, the light-emitting particles being embedded in the insulating material layer.

[0024] The light-emitting structure may include a semiconductor quantum well or a semiconductor PN junction.

[0025] The optical modulating device may further include an insulating material layer covering the permittivity change layer and the light-emitting structure.

[0026] The optical modulating device may further include voltage-appliers configured to apply respective voltages between the respective nanoantennas and the permittivity change layer.

[0027] The permittivity change layer may include a transparent conductive oxide.

[0028] An optical apparatus may include the optical modulating device, and a backlight configured to provide light to the optical modulating device.

[0029] The optical apparatus may further include a driving circuit disposed on the substrate and configured to control voltages applied to the respective nanoantennas.

BRIEF DESCRIPTION OF THE DRAWINGS

[0030] The above and/or other aspects will be more apparent by describing exemplary embodiments with reference to the accompanying drawings, in which:

[0031] FIG. 1 is a perspective view of a schematic structure of an optical modulating device according to an exemplary embodiment;

[0032] FIG. 2 is a cross-sectional view taken along a line A-A' of the optical modulating device of FIG. 1;

[0033] FIG. 3 is a graph obtained by computer simulation with respect to a change of permittivity in the optical